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MEMOIRS OF THE GEOLOGICAL SURVEY.

ENGLAND AND WALES.

THE GEOLOGY OF

THE COUNTRY AROUND

HALESWORTH AND HARLESTON,

(EXPLANATION OF QUARTER-SHEET 50, N.E.)

BY

W. WHITAKER, B.A., F.G.S., Assoc. Inst. C.E.,
AND W. H. DALTON, F.G.S.

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PREFACE.

The following brief Memoir describes the simple geology of a portion of the counties of Suffolk and Norfolk. The feature of most geological interest in the district to which it refers is, perhaps, the brick-earth at Hoxne, which since the discovery of flint-implements in it at the end of the last century has been the subject of much discussion. Some writers have classed it among Glacial deposits; but it is coloured on the Map and described in this Memoir as Post-glacial.

Some of the more important publications that relate to the geology of the district are cited in the footnotes; but for fuller reference to this literature the reader is requested to consult for Suffolk the Geological Survey Memoir on "The Geology of the country around Ipswich" (where a complete list is given up to the year 1885), and for Norfolk the Survey Memoir on "The Geology of the country around Norwich," in which the list of papers is completed up to 1881.

ARCH. GEIKIE,
Director General.

Geological Survey Office,
6th June 1887.

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NOTICE.

The greater part of the area contained within Sheet 50 N.E. of the Geological Survey Map was surveyed by Mr. W. H. Dalton, under the superintendence of Mr. Whitaker, who himself mapped a part along the eastern edge, and parts of the valleys of the Blyth and of its tributary the Bramfield stream. Mr. F. J. Bennett surveyed the north-western corner of the Map, and Mr. C. Reid a strip along the northern edge.

Mr. Dalton has contributed about one half of the Memoir. Some notes by Mr. Bennett and by Mr. Reid have been worked in, chiefly in the Appendix on Well-sections.

Mr. Whitaker has edited and arranged the whole Memoir, inserting much of the general descriptions, some notes on sections in Mr. Dalton's area, and details relating to the tracts surveyed by himself. The geological structure of these tracts is more varied than is the case in the greater part of the Map, and many noteworthy sections are here exposed.

H. W. Bristow,
Senior Director.

Geological Survey Office,
28, Jermyn Street, S.W.,
1st June 1887.

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THE GEOLOGY OF THE COUNTRY AROUND HALESWORTH AND HARLESTON.

CHAPTER I.

Introduction.

Area.

The area comprised in Quarter-Sheet 50, N.E., is about 205 square miles, of which about 25, in the N.W. corner, are in Norfolk, and the remainder in Suffolk.

There are two small towns, Halesworth and Harleston, and several large villages; but the occupations of the district being almost wholly connected with agriculture, the population is but small.

Rivers.

About half the area is drained by the *Waveney* and its tributaries. The main river, which rises at Lopham Ford (to the west), enters the district near Billingford, takes an E.N.E. course, and leaves us at Homersfield, flowing on to the Yare at Yarmouth. It receives, on the left, the brook which, rising near Tivetshall St. Margaret (to the north) flows by the Pulhams, Starston, and Reddenhall to the Waveney at Homersfield. On the right there are various tributaries: firstly, the collection of streams that meet together at Hoxne (the combined brook joining the main river within a mile) the chief being from the west (Eye, etc.); the next being a short one from near Denham; and the third starting near Bedfield (just to the south) and flowing by Worlingworth to Hoxne: secondly (omitting sundry very short tributaries), the stream that rises at various points, east of Wilby and south of Fressingfield and of Metfield, joining the river at Weybread: thirdly (omitting the short streams near Withersdale), the brook that drains what may be called the Southelmham district, as containing six villages of that name, and but two without it.

The streams at Brundish and Baddingham, at the southern part of our district, are the head-waters of the *Alde*.

The *Minsmere* rises near by, S.W. of Ubbeston, and flows E.S.E. to the sea, just beyond our border.

The *Blyth* rises near Laxfield, and flows, in a general easterly direction, to the sea at Southwold, some miles east of our area, receiving on the way the tributary from Bramfield on the right, and on the left various streams, from near Cratfield, from south and from west of Little Linstead, from near Wisset and Spexhall, and from Westhall and Brampton.

The streams in the north-eastern corner of the map, from W. and N. of Great Redisham, are part of the nameless system that flows into the sea near Benacre.

Geological Formations.

The geological divisions known to be present within the district are as follows :—

Recent	Alluvium.	
Post-Glacial (River Drift.)	Loam.	
	Gravel.	
Glacial	Boulder Clay.	
	Sand and gravel.	
	Boulder Clay and loam.	
	Pebbly gravel and sand.	
Pliocene	Chillesford Clay.	
	Upper Crag and sand.	
Eocene	London Clay	not at the surface.
	Reading Beds	
Cretaceous	Chalk	

Physical Features.

Beddingfield Church, in the south-western corner of the map, is at a height of 198 feet; and Tivetshall St. Mary, in the north-western corner, at 160. Between Baddingham and St. James Southelmham, several points exceed the height of 180 feet, and the hills along the eastern edge of the district range to about 110 feet above the sea. From the sloping plateau thus indicated, the valleys cut down more or less sharply to 10 feet at Blythford, and to 40 at Homersfield.

The plateau is formed of Boulder Clay, and the valleys have been cut through this formation to the various underlying gravels and sands, from Glacial Drift to Crag ; the bottoms of the valleys being then thinly covered by Post-Glacial deposits.

W. W. and W. H. D.

Cretaceous and Eocene Beds.

Chalk.

The Chalk has been reached in four wells in this district, one at Billingford, two at Hoxne, and the fourth at the house three quarters of a mile west of Bramfield Hall. These, with the known position of the surface of the Chalk at Beccles, on the north, and at Framlingham and Saxmundham on the south, show that surface to slope at about 21 feet a mile E.S.E. within the

area of the Lower Tertiaries; whilst beyond that limit it falls by denudation to about 15 feet a mile, appearing in the valley of the Waveney half a mile west of the edge of the map, at about 60 feet above the sea. The wells at Hoxne reach the Chalk at 40 feet below the sea-level, probably in a hollow of the chalk-surface which is only 47 feet below the sea-level both at Beccles (just north), and at Bramfield.

Reading Beds.

The full thickness of this formation appears to have been pierced in the Bramfield well in the 36 feet of clay overlying the Chalk (*see* p. 36). Whether the clay in a similar position at Hoxne (pp. 37, 38) is of the same age, or a part of the Crag series is doubtful, but if the former is the case, it must be either an outlier or a promontory much beyond the general trend of the Lower Tertiary boundary. No trace of anything older than the Crag occurs on the Chalk at Beccles or to the north-west, or of anything older than the Glacial beds at or west of Framlingham. If the Hoxne clay is an outlier, its limits westward are indicated by the outcrop in the Waveney, but the "loam" of the Billingford section (p. 34) might represent it. Some plastic blue loam seen in ditches half a mile north-west of Halesworth station may belong to this series.

London Clay.

The basement-bed of the London Clay seems to be present in the Bramfield well to a thickness of nearly seven feet (*see* p. 36). The mass of the London Clay has been removed by denudation, but if Bramfield is its western limit, the formation may be present in considerable thickness on the eastern edge of our district, where its base may be some 50 feet below the sea-level.

W. H. D.

Upper Crag.

General Remarks.

In order to avoid using either of the names Red Crag or Norwich Crag (which amount only to applying a distinctive term to two slightly different conditions of one formation), and from feeling at a loss as to which of the two should be here used, the name Upper Crag is now adopted, and the reasons for this step will be gone into more fully in the Memoir on the tract to the east (Sheet 49, N.)

The Crag is the lowest formation seen at the surface in the district, saving perhaps for the loam north-west of Halesworth Station (*see* above). It consists of ferruginous sand of varying texture, occasionally charged with shell-fragments, sometimes with casts or impressions of shells in iron-sandstone or ironstone, but mostly without trace of fossils, any that may have been

present having been dissolved out by percolating acidulated water, which would have a free course in such beds.

The bottom not being seen at the surface, and the formation being rarely penetrated in wells, we know little as to the thickness of the Crag. This reaches 88 feet at Hoxne (*see* p. 38), but the Crag is not recognizable in the account of the boring at Bramfield, though outcropping on all sides of the site.

W. W. and W. H. D.

Valley of the Minsmere.

On the right side of this valley, at and a little below Yoxford, there is an outcrop of sand probably of Crag age.

On the left bank it is possible that Crag sand is touched in the pit at the brickyard by Hulverstree Houses, above Yoxford (*see* p. 12).

The sand was seen, beneath Boulder Clay, just north of the high road, nearly a mile E.S.E. of Yoxford Church, and again, without the clay-capping, half a mile from the church.

On the left bank the sand crops out about half a mile below Hulverstree Houses, and the outcrop is then almost continuous, though whether all that has been coloured as Crag is rightly so is not a matter of certainty.

At Cockfield Hall (Yoxford), a pit, mostly overgrown, close to and N.E. of the house, showed the following section in 1882 :—

Boulder Clay, at the highest part, ? 5 feet.
Light-coloured false-bedded sand, finely gravelly, with a gravel layer at the base, chiefly of pebbles (one large flint noted), 8 feet or more.
? Crag. Brown sand, about 12 feet.

The sands are also seen in road-cuttings and railway-cuttings southward of Darsham station, and are touched in pits sunk in Boulder Clay thereabouts.

The light-coloured, nearly white sand, in the pit about half a mile S.E. of the station is much like the upper sand of Dunwich Cliff.

On the road about three quarters of a mile E.S.E. of the station is a pit showing a somewhat similar section to that of Cockfield Hall.

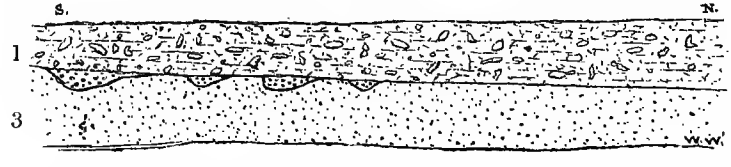
Further S.E., close to the marsh, there is a little irregular gravel (not enough to map) over sand.

On the road just east of Darsham Church there is a trace of gravel (a few inches thick) beneath the Boulder Clay, and apparently there is sand below.

A section on the northern side of the road about an eighth of a mile N.N.W. of The Wilderness, Westleton, showed Boulder Clay, separated from the sand by a layer of gravel.

The western part of the pit at the back of the small farmhouse on the northern side of the lane about half a mile north of Westleton church, was open in 1880, and gave the section in Fig. 1 :—

Figure 1. *Section in a Pit about half a mile North of Westleton Church.*



1. Boulder Clay, up to 8 feet.
2. Fine pebble-gravel with sand, filling small hollows.
3. Crag ? nearly white sand, up to 8 feet or more.

At the pit about a quarter of a mile south-eastward from Westleton church the section was as follows :—

Pebbly gravel, scooping into the bed below.
Sand, light-coloured, bedded.
? Chillesford Clay, from 12 to 18 inches, and not traceable many yards.
Sand (? Crag).

Dunwich Valley.

The head of this valley, which runs to the sea near Dunwich (Map 49, N.), cuts into Crag sand northward of Westleton, but there is no noteworthy section.

Valley of the Blyth : Up the Right Side.

Up the right bank, including the Bramfield tributary valley, there seems to be a continuous outcrop in our district, to Ubbeston ; whilst down the left bank, the outcrop is broken in three places ; but it is at the lowest of these that we meet with the only good exposure of shelly Crag, near Bulchamp Workhouse, Blythford.

Up the tributary-valley, ferruginous sand was seen to a depth of 8 feet under pebbly gravel, 12 feet thick, about 200 yards south of De Ufford's Bridge, Thorington.

The pit nearly a third of a mile west of Thorington church was overgrown in the southern part, but the following section was open, in 1880 :—

Glacial Drift. Brown loam, with stones (mostly angular flints); with an irregular bed of sand at the base, up to 5 feet thick, but thinner as the ground falls northward (? weathered Boulder Clay, with a trace of Glacial sand).
Sandy pebble-gravel, 4 to 6 feet, or rather more, ? scooping into the sand beneath (junction partly hidden by talus).
Light-coloured sand, with a few small stones in the top part. Apparently a gravel layer at bottom (only to be seen at two spots), 9 feet on the south (where the gravel above is thinner), 5 feet on the north (where the gravel is thicker).
Crag. Sand, several feet.

This section agrees with that of part of the Dunwich cliffs. The pebble-gravel is the Westleton shingle, and whilst the sand next beneath may belong to the Crag (with which it must be mapped), there seems a possibility of its representing the Bure Valley Beds of Norfolk, in which case the last and the Westleton Beds might not be simply two names for one thing.

As the top bed forms a sandy gravelly soil, it is better, perhaps, in mapping to let it go with the gravel.

Along the lane down the slope (northward) about half-a-mile E.N.E. of Bramfield Church, Boulder Clay is shown at top. Then a little brown loamy sand with large flints (the weathered base of the Boulder Clay) over sand, with thin loamy layers and patches. Farther down, pebble-gravel is seen to lie irregularly on this sand, which latter, therefore, one classes as Crag. In the river-bank, just east, there is some ferruginous sand.

A little pebbly gravel is again to be seen over the sand about an eighth of a mile W.S.W. of Castle Yard.

The large old pit on the eastern side of the high road, about three quarters of a mile southward from Bramfield Church, is overgrown, except at the northern part, where sandy pebbly gravel was seen to a depth of nearly 15 feet, when it was hidden by talus : the bottom part, however, was clearer at the east, and then light-coloured sand was seen beneath the gravel to a depth of

6 feet. This sand, which presumably is Crag, must rise up beneath the gravel. Near the entrance there is pebbly gravel, again at a lower level; so that the gravel seems to rest irregularly on the sand.

Returning down the left side of this tributary valley, no section was noted until getting below Bramfield, where an old pit south of Page's Farm gave a sort of epitome of the local geology.

The sides of this small pit, which is about two thirds of a mile N.W. of the church, were mostly hidden; but at the northern part one could see, beneath a clayey gravel (? wash), several feet of light-coloured sand, gravelly at one spot; and at the south the following succession could be made out:—

Boulder Clay, a trace.
Buff sand, gravelly at the bottom, 4 feet or more.
Brown loam, stony at top, 4 feet shown.

The relation of the loam to the sand of the northern part cannot be made out. Can the loam be of the same age as that in the pebbly gravel on the east of Bramfield? (*see* pp. 13, 14). If so, the sand in question may be Crag, going below the loam.

Three-quarters of a mile W.N.W. of Wenhaston Hall, a gravelly wash was seen over brown sand; on the north of the road more than half a mile west of the Hall there is sand, with a few pebbles at one part; and on the southern side of the same road about a third of a mile west of the Hall there is a little patch of pebbly sand over the sand, the latter of which is also to be seen at the Hall, and at the spur at the western part of Wenhaston Black Heath (capped by a little gravel).

Returning to the main valley, just eastward of Wenhaston church, a section was noted as showing a gravelly soil over light-coloured sand, with some small stones in the top part, and with a line of stones in the middle, which is suggestive of the upper sand of the Dunwich Cliff (*see* Memoir on 49, N.)

More than a third of a mile N.W. of the church the sand was again seen, beneath a little gravel.

In a sand-pit less than a quarter of a mile westward of Wenhaston Station some pieces of soft sandstone lying about contained bits of shells (? Echinoderm) and casts of *Balanus*.

At Mill Heath, north-west of Wenhaston village, there is a line of old pits facing southward. At the top, on the road, there is pebble-gravel up to 6 feet thick, loamy at the base, and resting irregularly on sand. Lower down all is sand, false-bedded and light-coloured. At the bottom a fresh cut showed brown ferruginous Crag-like sand; and all the sand, of which there must be 20 feet, belongs to the Crag. Just westward an open piece showed sandy false-bedded pebble-gravel (or pebbly sand at the lower part), up to 12 feet thick, including the gravelly soil, resting in great scoops on the sand. Through this irregularity of junction the sand indeed seems to come nearly to the surface in parts of this small Heath, with only pebbly soil above.

At the spur a little south-east of Mells Chapel an old pit shows pebbly gravel over sand.

W. W.

The Crag sand looks less ferruginous where protected by the Chillesford Clay at the brickyard on the London Road about a mile southward of Halesworth Station (*see* p. 9), but appears with its usual characters at Wenhaston Place to the south-west.

At Walpole a large pit below the windmill shows pebbly sand, intermixed with grey, green, and yellow clay, resting with an uneven junction on fine white and brown sand, slightly micaceous, and in places somewhat loamy. This corresponds with the description of the sand met with from 70 to 123 feet deep in the Bramfield well (*see* p. 36), but not there recognised as Crag. The sand is again seen in a pit about 300 yards west of Philpots Farm.

It has been dug for use in the brickyard, half a mile west-south-west of Haveningham Hall, where it occurs in the form of whitish bedded sand, streaked in the upper part with ferruginous clay.

W. H. D.

Valley of the Blyth: Down the Left Side.

The following section occurs in a pit opposite the Huntingfield Arms, about half a mile south-east of Huntingfield church. There are some small faults and some slight twists in the bedding.

Sand and pebbly gravel, a few feet.

? Crag { Finely bedded sand, with ferruginous and clayey layers; seems thicker W. than E.; up to 3 feet or more.
Brown sand, with a few pebbles and a broken line of ironstone-nodules near the top; ? 8 feet seen.

A quarter of a mile east of the church highly ferruginous sand is seen in the floor of an old gravel-pit. The sands are seen at the junction of the roads north-west of Haveningham Hall, and again near College Farm, Cookley.

A pit by the farm, an eighth of a mile west of Cookley church, gave the section below in 1882:—

? Glacial Drift { Sandy soil and sandy gravel (very pebbly); up to 6 feet or more.
Light-coloured sand with thin layers of clay, and with pebbles in the lower part; up to 4 feet.

? Crag. Light-coloured sand with ferruginous stains; 4 feet seen.

At the farmstead on the southern side of the road, more than a mile east of Cookley church, a small pit gave the following section:—

Glacial Drift { Gravel, with many pebbles.
Evenly-bedded light-coloured sand, 3 feet.
" " " with a few pebbles, 4 feet.

? Crag. Highly ferruginous sand, in the bottom of the pit.

Gravel was seen overlying the Crag sand in a pit in a field nearly half a mile south-south-east of Halesworth church.

Leaving the main valley for the Halesworth system of tributaries, a mile westward of Halesworth church fine white sand is seen under coarse angular gravel, and traces of sand of the same character occur up the valleys towards Cheddiston and Wisset.

Red sand is touched in the floor of the pit at the railway-junction south of Halesworth Station (*see* p. 15).

From Halesworth to below Holton, in the main valley, the Crag does not crop out, the overlying pebbly gravel running down to the marsh.

A pit at the back of the farm on the northern side of the road, about half a mile north-westward of Blythford church, gave the following section:—

Soil.

Pebbly Gravel { Pebble-gravel; up to 4 feet - - - } 6 feet.
Light-coloured false-bedded sand; up to 3 feet - }
Gravelly sand, with a marked layer of large pebbles at top; nearly 5 feet.

Crag? Bright brown sand; over 2 feet shown, then hidden by talus.

A small pit in a field about a quarter of a mile N.N.W. of Blythford church again showed the junction of the gravel and the sand, as below:—

Dark brown pebble-gravel, 4 to 5 feet. At the base in parts, with more or less tabular masses of grey clay, 6 inches thick, possibly broken up Chillesford Beds.

Crag? Yellowish sand.

Another pit at the bottom of the adjacent lane shows gravelly layers in similar sand. Whether this sand is Crag in place, or in a resorted condition, with pebbles introduced, is uncertain, but the upper part of the former section is certainly in the pebble-gravel series next to be described, and we have provisionally included all the ferruginous sand in the Crag series.

The sand-pit, on the eastern aide of the lane, about a quarter of a mile E.N.E. of the church, is in light-coloured aand, with some gravelly layers, one near the bottom, below which layer the foot or two feet of sand shown was clear of pebbles. This section may also be the junction of the pebbly series (here chiefly sand) and the Crag.

W. W. and W. H. D.

The sandpit at Bulchamp Union Farm, S.E. of the house, was partly hidden (1878), but the part next the house showed the following section :—

Soil, loam, and sand, with a little Boulder Clay at the bottom; ? up to 6 feet.
Sand, sometimes with a gravelly layer; about 3 feet.
Boulder Clay; 3 feet seen, then hidden by talus.

The beds seem to rise eastward, but at a few yards off the relation to the above is obscure, the succession being :—

Glacial Drift. { Sandy soil and a little Boulder Clay (? the lowest bed of the last); up to 3 feet - - / Gravel, mostly coarse, of flints, flint-pebbles, and other stones; at one part a large mass of septaria at the base; up to 5 feet, resting irregularly on the next - - } 6 feet to 0.

? Crag. Bedded and partly false-bedded ferruginous and grey sand (rising up to the surface southward), with a few clayey layers; partly hardened to an iron-sandstone, of which there are blocks at the bottom of the pit; ? up to nearly 20 feet (where bare).

It would seem, therefore, as if there were a hollow here in the Crag, filled with Drift.

It is at the southern end of this spur, close to the border of our district, in an old pit close to the river, that shelly Crag occurs as well as the usual unfossiliferous sand, and it is from this pit, probably, that Prof. Prestwich got the number of fossils of which he gives a list.* Instead of reproducing that list here it will be given in the Memoir on the tract to the east (Sheet 49, N.), in which tract other fossiliferous sections of Crag occur.

In the Westhall tributary valley, opposite Sotherton, there is a narrow outcrop of sand, from beneath the pebbly gravel, and a sand-pit three quarters of a mile W.N.W. of Westhall church seems to reach the same bed, the section being as follows (1882) :—

Pebbly Gravel Series. { Sandy soil and light-coloured sand, with pebbly gravel; up to 6 feet or more. / Wet brownish sand and loam, bedded; up to nearly 2 feet. / Light-coloured sand, with pebbly gravel, lying irregularly on the next; up to 7 feet.

? Crag. Light-coloured and ironstained sand, up to 7 feet seen.

W. W.

Waveney Valley : Tributary.

About 300 yards north-west of Harleston Station, Crag is dug for paths, &c. in a pit showing the subjoined details :—

	Feet.
Stiff blue clay - - - - - -	3
Red loamy sand - - - - - -	3
Very coarse gravel - - - - -	8
Fine tawny sand, with curved bedding-lines, and with shells of *Cardium, Mya, Balanus*, &c. - -	10

* *Quart. Journ. Geol., Soc.*, vol. xxvii., p. 344.

On the other side of the stream, in a small plantation a quarter of a mile north of the station, is a pit in grey, bedded sand, with small stones and water-worn fragments of shells. This passes up into buff sand, capped in part by a clayey band, on and irregularly crossing which is coarse angular gravel. The only recognizable shells occurring in this pit are of the genera *Cardium*, *Cyprina*, *Tellina*, and *Turritella*.

W. H. D.

Chillesford Clay.

Of this bed, a micaceous sandy clay of varied tints of grey, turning brown by exposure, there is but one certain occurrence, with one good section, in our district, near Halesworth. The bed forms the top of the Crag Series, and its absence sometimes makes it difficult to fix the division between Crag and Drift. Judging by the irregular way in which the pebbly gravel often overlies the Chillesford Clay, it seems likely that the absence of the latter is to some extent owing to erosion.

In a small old overgrown hollow, some 3 feet deep, on the northern side of the road, S.S.W. of Westleton church, there was a little messy pebble-gravel (possibly a wash) splashed, as it were, on to brown clay (not unlike some London Clay), which may, perhaps, be of Chillesford age.

There is again a sign of the possible presence of this bed in the pit at Westleton Moor, S.E. of the church (*see* p. 5).

At Wenhaston Black Heath there is a little sandy pebble-gravel over light-coloured sand, with layers of pale grey clay, and here and there a few small pebbles. At one spot, in the central part, the clay-layers are more developed at top, and the bed may represent Chillesford Clay; near by (eastward) is a pond, and the ground is damp, so that there would seem to be a clayey bed here.

Between the railway and the London Road, about a mile southward of Halesworth Station, is the brickyard referred to by Mr. S. V. Wood, Jun. and others, as the Halesworth Kiln.

The section here is the only exposure of undeniable Chillesford Clay in the district, and it fortunately exhibits the relations therewith of other beds in a fairly definite manner. The following subdivisions are present:—

Boulder Clay with much Chillesford Clay (partly crushed, partly in large masses) and wedge-shaped bodies of sand. The lowermost 6 inches of the clay brown by oxidation from upward percolation of water, the rest blue and chalky, except for the blocks of Chillesford Clay and sand; 10 feet.

Seven feet of compact yellow sand without pebbles, noted by Mr. S. V. Wood in 1868, appeared in 1879 in one point only (near where the same observer noticed "horizontally bedded sand with seams of shingle, 2 feet") as sand with grey pebbles; 7 inches.

Chillesford Clay, finely bedded; 12–15 feet.

Ferruginous (Crag) sand, with fine gravel; 8 feet.

The late Mr. S. V. Wood, Jun., kindly contributed a drawing of an earlier section, at the northern end of the field, giving the following details:—

Boulder Clay, 6 feet.

Pebbles (Bure Valley Beds), up to 3 feet; but cut through sharply by the Boulder Clay in the middle part, where also the bed below rises up slightly, and there is nothing between the two clays.

Chillesford Clay, tawny and sandy in the upper part, stiffer and bluish at the base.

The Chillesford Clay forms the surface for a very short and narrow space, being deeply eroded by the currents which brought thither the succeeding pebbly gravel, and both these deposits being again torn up and incorporated in the Upper Boulder Clay.

Near the eastern edge of the district, in the Westhall Valley, judging by the character of the ground on the southern side of the road, a quarter of a mile eastward of Westhall Hall, there may be a trace of this clayey deposit.

W. W. and W. H. D.

CHAPTER 2.

Pebbly Series.

General Remarks.

The beds of this series vary within our area, for, whilst having the character implied by the above name about Westleton and Halesworth, to the west and north-west they change into fine sands and loams, each exposure showing different peculiarities.

The series has been classed with his Bure Valley Beds by Mr. Wood, Jun., and has been named after the village of Westleton by Prof. Prestwich, but for our present local use the above lithological name has been preferred, as not pledging us in question of classification, for reasons that will be given in the Memoir on the tract to the east (Sheet 49, N.), in which these pebbly beds have their greatest surface-development. In that Memoir, too, a short history of opinions as to these beds will be given. It is enough here to say that they come between the Glacial Drift and the Chillesford Clay, and that their kinship to the former above, or to the Pliocene below, is left an open question; they are bracketted with neither in the index of our Map.

The chief constituent of the gravel is flint pebbles, but there are also pebbles of quartz and of other rocks, and some subangular flints.

W. W. and W. H. D.

Valley of the Alde.

Although there is no outcrop in the small tract belonging to this river-system, yet the series is present, at no great depth underground, at one place. The feeder of the Alde that passes through Baddingham cuts through the Boulder Clay a little above the village, and generally reaches Glacial sands, but at a quarter of a mile north of the church, a pit shows that the course of the last-named series is here interrupted by a boss of older beds, consisting of the following sequence:—

Glacial Drift	Blue Boulder Clay - - -	7 feet.
	Brown stony loam (= Lower Boulder Clay) - - - - -	7 „
Pebbly Series	Coarse sand and gravel - -	4 „
	Fine micaceous clayey sand.	

The Pebbly Series, being below the floor of the valley, cannot be shown on the map.

W. H. D.

Valley of the Minsmere: Left Side.

In this valley the pebbly beds appear in small isolated outcrops only, on the northern side, until reaching Westleton, at the edge

of our district, where they appear in force, forming part of the large area in Sheet 49. On the southern side of the valley we saw no trace of them, the Glacial Drift mostly reaching down to the marshes, and, where not doing so, being underlain by Crag sand.

At the brickyard on the eastern side of the road at Hulverstree Houses, more than a mile N.N.W. from Yoxford church, the top part of the large pit was cut back into a Boulder Clay pit, about 15 feet deep. The general section was as follows, the junctions of the beds being even, and some parts of the pit overgrown:—

Grey Boulder Clay, ending off on the east; the bottom 2 feet or so sometimes consisting chiefly of pebbles of chalk, with some flints; and at one place a like bed, but finer, and lenticular, in the clay. Sometimes with brown clayey stony sand, up to 15 inches thick, at the base.

Sand: at the east, brown and light-coloured, contorted, and with an interrupted gravel layer at or near the base; at the middle, brown, with some loamy layers; further west, with pebbly gravel in the upper part; at the west, sand and gravel (resting irregularly on sand with loamy streaks); up to 8 feet seen.

Sand, with grey clayey layers; at the east, light-coloured; at the middle very evenly and finely bedded; up to 7 feet seen.

Sand has been found beneath [? Crag].

It is hard to decide whether the top sand should be classed as Glacial, or with the pebbly gravel, in which latter case the more clayey mass beneath may be taken as representing the Chillesford Beds; whilst, on the other hand, even this may be Glacial. In mapping, it was thought safest to correlate this sand with beds elsewhere pebbly: the bed above seemed to be inconstant.

At Darsham there are two distinct outcrops of pebbly gravel south of the village.

On the hill about three eighths of a mile south-westward of the church, a pit on the northern side of the road showed more than 15 feet of shingle, false-bedded (?) at an angle of about 15° northward, the divisions of the layers being sharply marked. There was a trace of Boulder Clay at top, and on the other side of the road this clay was seen to abut against a face of the gravel.

At the irregularly-pitted and much cut away hill (covered with gorse and heath), on the opposite spur of the side-valley about half a mile south of the church, there is again pebbly gravel, many feet thick, and sand (mostly more or less gravelly) the sand being in the greater quantity.

About a quarter of a mile N.W. of Vale House, S.W. of Westleton, there is a patch of sand with pebbles.

On the high ground of Westleton Moor the pebbly gravel and sand may be well seen in pits, and it is from the development of the beds here that Prof. Prestwich was led to give them the name of "Westleton Sands and Shingle." He says, "They attain a thickness of from 30 to 40 feet, and consist of a series of stratified beds of well-rounded flint-pebbles imbedded in white sand, and with two or three subordinate beds of light-coloured clay . . . . . Mixed with the flint-pebbles are a few small pebbles of old rocks, with a considerable number of white quartz-pebbles."*

North of Westleton the pebbly gravel mostly comes between the Boulder Clay and the Crag sand, at the head parts of the valleys of Dunwich and Westwood (Sheet 49, N.). On the small triangular common about a quarter of a mile E.S.E. of Hinton Hall, a pit, marked on the Map, gave a good section of false-bedded gravel, with light-coloured sand; and over a quarter of a mile to the north was another section of the gravel.

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* *Quart. Journ. Geol., Soc.*, vol. xxvii., p. 461.

Valley of the Blyth: Up the Right Side.

There is an outcrop, though gradually narrowing, for some way up this valley, and also up the Bramfield tributary; but sometimes, where the pebbly character is less apparent, it is not easy to be sure whether we are dealing with this series or with the overlying Glacial sand and gravel. From this cause there is some doubt in the mapping of the higher part of the valley of the Blyth, on both sides; but this is really a matter of little moment; for to what formation we may assign the narrow outcrops of sand and gravel between the Boulder Clay and the Crag is a purely theoretical question, and that of small importance, there being no doubt as to the stratigraphical position of the beds, locally.

Both gravel and sand occur north of Hinton Lodge, and the outcrop runs a short way up the tributary Bramfield valley, some 4 feet of gravel being seen in a field a little north-eastward of De Ufford's bridge, and a greater thickness in a neighbouring section (*see* p. 5).

The pit marked on the map just N.N.E. of Thorington Farm (S.E. of the village) gave the following section:—

A little gravelly soil at the highest part.

Pebbly Beds.
- False-bedded bright buff and light-brown sand (much like Crag sand), partly gravelly, especially in the lower part (the top part hardly so): about the middle a lenticular layer of pebbly gravel. Rests evenly on the bed beneath, as far as seen. ? 18 feet.
- Pebble-gravel (shingle). 6 feet, below which I dug into sand to a depth of a foot.

A shallow old pit, on the northern side of the lane, about an eighth of a mile N.W. from Thorington church, shows the shingly gravel, which is again to be seen in the pit to the west (*see* p. 5).

A little pebbly gravel is seen along the lane E.N.E. of Bramfield church (*see* p. 5).

The pit nearly a quarter of a mile eastward of Bramfield church, on the southern side of the lane, just east of the schools, gave a very complicated set of sections in 1880, when it was open at three parts; on the esstern side, not far from the road; on the same side, almost at the southern end; and at that end (slightly to the west), the latter two being separated by only a very narrow spur.

Taking the section, as one goes into the pit, at the first part the following succession was seen:—

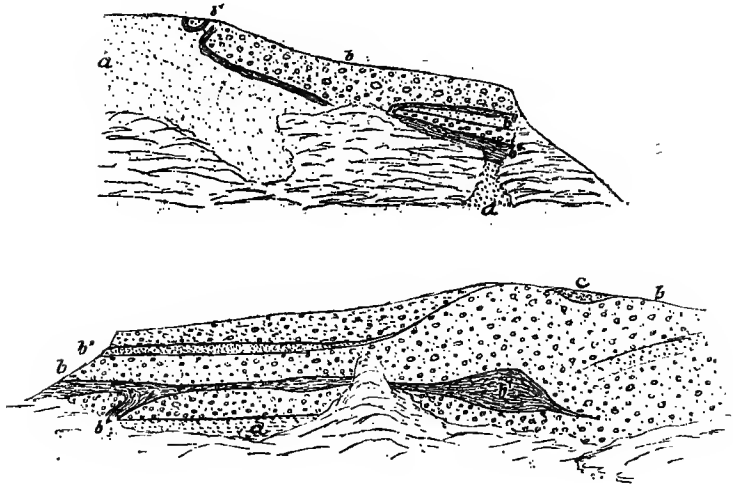
b. Pebble-gravel and sand, cutting down into the bed beneath (junction much hidden). Near, or sometimes at, the base, an irregular bed of brown loam (*b'*), mottled grey, clean, and not unlike the basement-bed of the London Clay, so that it might be taken for Chillesford Beds; this varies from only a few inches in thickness to more than 2½ feet (where it had sunk to the base of the pit, and was not bottomed).

a. Sharp yellow sand, over 4 feet. (Crag.)

The second opening was at first only in the brown sand (*a*), except for soil, to the depth of about 12 feet; but in the spur between this part and the third opening the section was as in Fig. 3, the brown clay at the base of the gravel here again thickening to the hollow, and now partly containing small stones, there being also another clayey layer from 0 to 2 feet above.

Figures 2, 3. *Sections in a Pit by Bramfield School.*

Length about 10 and about 20 yards, respectively.



c. Boulder clay.
b. Pebble-gravel; up to about 15 feet; with fine sand *b''*, and with brown clay or loam *b'*.
a. Sand (Crag).

On turning the spur, into the third opening, the gravel was found still lower, and the clay bed was divided by a mass of gravel at the end of the spur, beyond which more gravel set in below the clay (*see* Fig. 3), which is on the other side of the spur from Fig. 2.). Where the clayey bed thickens, as it does to 4½ feet, it contains stones, and is much like the Norwich brickearth, or lower till.

At the southern end of the pit, the brown clay came in again, near the base, as a thin lenticular mass, and, on the west, the gravel was less pebbly, being then more like ordinary Glacial gravel.

This section, though small, is important, for, if one is right in classing the pebbly gravel with that of Halesworth, &c. (which has been taken to be of the same age as the Bure Valley Beds of Norfolk), then the presence in it of a till-like sandy clay tends to prove that such beds should be classed rather as Glacial than with the Crag. The section, however, is peculiar, and like no other in the district. The gravel may turn out to be only a pebbly version of the Glacial gravel, made up from the destruction of an older pebble-gravel. The occurrence of stones in the sandy clay is against classing it as Chillesford Clay, the position of which it seems almost to hold.

Some sections to the south have been already noticed (pp. 5, 6).

Down the left side of this tributary valley pebbly sand was seen, beneath Boulder Clay, in a pit half a mile west by north of Wenhaston Hall, and there are sections at and around the village which have been described above

(pp. 6, 9), besides a pit in sandy gravel over sand with clay, just west of the Star inn, and another in sand and gravel about an eighth of a mile east of the church, whilst at the top of the spur S.W. of the Railway Station there is sand with pebbly layers.

W. W.

Pebbly gravel forms an irregular promontory, on a basis of Crag sand, eastward of Mells Chapel. The variations in thickness of the gravel observed at the kiln south of Halesworth (*see* p. 9) are due partly to the irregularly-eroded surface of the Chillesford Clay, and partly to erosion of both pebbly beds and clay at, or before, the formation of the Boulder Clay.

Further west, the pebbles form the shoulder of the hill between the brickyard and Wenhaston Place, after which they are lost for two miles, and on reappearing southward of Walpole the series consists of white and grey sand with grey pebbles and seams of grey clay, followed by brown earthy loam, the Lower Boulder Clay, with few stones and yielding scantily fragments of shells (*Cardium* and *Tellina*), the Upper Boulder Clay covering all. At the brickyard half a mile west-south-west of Haveningham Hall, coarse grey sand is reached under similar loam, here also capped by Boulder Clay.

Valley of the Blyth: Down the Left Side.

On this side of the valley there is a continuous outcrop from beneath the Boulder Clay (the Glacial sand being absent), from the neighbourhood of Halesworth downward, when it joins the broader area in Sheet 49, N., with which also the outcrop up the Westhall tributary-valley is connected.

The pebbly beds occur up to Cookley side-valley; again set in south of Halesworth, and range through the town and up the Wisset and Spexhall side-valleys. In the latter they are well seen at Bullock Fair Farm.

South-eastward of the station at Halesworth they appear as a thick mass of grey pebbles, in a matrix of sand, a large pit showing a thickness of 30 feet, with marked current-bedding. Above these pebbly beds, close under the Boulder Clay, and nearer to the station, light-coloured sand, bedded with layers of pebbly gravel, was seen at a spot now covered by the embankment of the Southwold line, whilst the adjacent cutting, made for the entrance of that line to the station, shows blue Boulder Clay with nests of coarse sand (? in a line).

Masses of grey pebble-conglomerate project from the hill-side east of Holton. In the south-western corner of the park a pit showed pebbly soil over sand; and there is a pit in gravel and sand about half a mile S.E. of the church; and the lower part of the series is touched in several cuttings on the Southwold Railway.

Other exposures of these beds near Blythford have been noticed in describing the Crag (pp. 7, 8).

On the eastern side of the road, about a mile N.N.E. of the Workhouse, there was a pit in sand, with gravel at the base.

The Westhall tributary valley is chiefly cut down to beds of this series, and a pit showing the junction with Crag sand has been described at p. 8.

Valley of the Waveney.

We have here but one outcrop of importance, in the neighbourhood of Withersdale, the valley not having been elsewhere cut below the Glacial Drift, except over very small areas, in our district. The usual pebbly character of the series is now but little seen, sand with loamy or clayey beds mostly replacing the gravel and pebbly sand that we have hitherto met with.

On the hill-side facing Withersdale Cross brickyard, about three quarters of a mile N.W. by W. of Withersdale church, is a pit showing (1881) the following section:—

	feet.
Light-coloured sand, very calcareous, with tufa-pipes along rootlet-lines	7
Grey pebble-gravel	1
Sand	1
Marly clay	8 in. to 1
Light-coloured sand	1
Grey pebble-gravel	½

In the large brickyard at Withersdale Cross is seen a complicated series of alternating and inosculating beds of laminated loam, fine and coarse sand, and pebbly gravel. The section varies in detail from point to point, but even within its length can be seen the diminution westward of the pebble-constituent, and the increase in thickness of loamy beds.

At the south-western end of the pit we find, under a surface-wash of gravel, 10 or 15 feet of stiff laminated clay, contorted in the upper part and weathering to crimson, orange, or grey, according to the porosity of the beds, and the consequent oxidation of their contained iron. Below this clay is gravel, to the depth of 3 feet, and this is underlain by sand, proved to a depth of some 15 feet. Similar beds appear to have been met with in a pit, now run down and ploughed over, about 200 yards south-east of Hulks Grave, and in the neighbourhood of Pits Hall are several such old pits.

Alternations of fine laminated sand and yellow sandy brickearth are seen in a run-down pit half a mile south of Mendham Priory, with traces at top of Boulder Clay and gravel. 200 yards northwards from this (the interval being a series of old Pottery pits, completely grassed over) a pit showed, in 1882, the subjoined particulars:—

	feet.
Loam, including soil	4
Bright yellowish sand, with a little fine gravel and a coarser seam at the base	about 12
Grey sandy loam passing down into the bed beneath	4
Firm grey sand	5

At the northern end of this pit a deposit of buff sand and pebbles rests against a steep bank formed by these beds.

A few miles higher up the valley there seem to be small outcrops on either side.

Near Syleham Mill the gardens south of the road are formed in an old excavation, the weathered face of which shows coarse gravel, with a clayey matrix, above and grey bedded loamy sand below.

To the west, near the weaving shed, we find white marl, grey Boulder Clay, and grey sand confusedly bedded together, and beyond the shed the road-bank consists of very firm, grey, bedded, sandy loam.

The "lump-pit," at Brockdish, nearly opposite, where "clay lumps" are made for rough buildings, showed in 1880 the following section:—

	feet.
Reddish and light-coloured sand and gravel, resting very irregularly on the next	—
Boulder Clay, grey at top, whiter below	12
White sand	3
White clay, said to reach to	15

At the back of the school, opposite this pit, the bank is formed by Boulder Clay, and the building stands upon a series of marls interbedded with marly sands, all finely laminated, and apparently the equivalents of the white clay of the lump-pit.

The old pits near Shotford Bridge, south of Harleston, show the upper part of this series indistinctly, but my colleague, Mr. C. REID, noted a consolidated mass (now broken) 12 × 10 × 4 feet in size.

The lower part of the following section of a pit between road and railway, about a mile E. of Harleston, probably belongs to the series under description :—

	feet.	in.
Bedded gravel - - -	6	0
Greyish-brown stony loam - -	3	4
Fine pale yellow current-bedded sand -	5	0

W. H. D.

CHAPTER 3.—GLACIAL DRIFT.

Lower Boulder Clay.

This bed, the representative of the Cromer Till of North Norfolk, is only present in isolated patches in this district. It consists of a sandy stony loam, generally brown, its porosity permitting the oxidation of its contained iron by percolation of atmospheric waters.

In the case of small isolated patches it is, of course, often uncertain whether we are dealing with this lower bed, or with the more general and thicker mass that here forms the highest division of the Glacial Drift.

Valleys of the Alde, of the Minsmere, and of the Blyth.

The section at Baddingham, showing this bed overlying the pebbly sands, has been noted on p. 11.

A seam of Boulder Clay separates the Crag sand from the Glacial gravels on the road between Yoxford and Darsham Station.

A pit on the right side of the Blyth, more than a mile E.N.E. of Thorington church, on the western side of a hedge between fields, was mostly ploughed over (1878) on the east, but the highest part showed the following succession :—

Sandy gravelly soil.

Glacial Drift. { Brown bedded sand and loam, like that seen in a pit a quarter of a mile south of Blythburgh church (in 49, N.) which there seems to belong to the Chillesford Beds; up to about 4 feet.
Stony loam, soon passing down into :—
Grey, very sandy Boulder Clay (sometimes almost a sand with stones); ? 8 or 10 feet.

? Sand below.

The sections near Walpole and Haveningham have been described on p. 15.

A pit on the eastern side of the lane about a third of a mile S.S.W. of Philpots Farm, Walpole, gave the following section :—

A little Boulder Clay (Upper).
Brown stony loam, with pieces of shells (? Lower Boulder Clay), 7 feet.
Sand and gravel (Pebbly Series ?).

Valley of the Waveney.

The late Mr. S. V. Wood, Jun., favoured us with notes on two sections no longer visible, in the neighbourhood of Withersdale Cross. The first section, on the hill some 200 yards southward of Withersdale Cross, showed dark (Upper) Boulder Clay lying erosively on bedded brownish-grey gritty loam, full of small chalk-stones. The other, on the west of the road at the back of Withersdale Street, showed a very similar sequence, but with many sand-galls in the loam, more extensive erosion by the upper clay, and below the loam was seen 10 feet of bedded sand with fine gravel.

The Weybread brickyard, a mile or more eastward of the church, is the one that has been referred to by Mr. S. V. Wood, Jun., as two and a half miles S.S.E. of Harleston, and as three fifths of a mile N.N.W. of Pits Hall. Fig. 4 is from a sketch of the clear part of the section made in 1879.

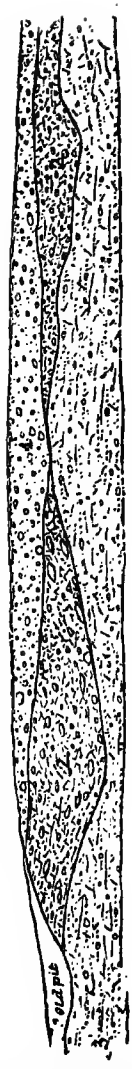
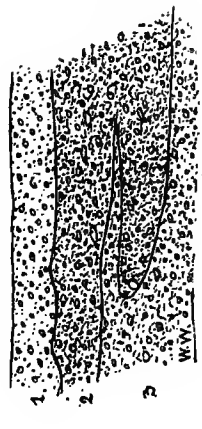


Figure 4. Section in Weybread Brickyard.

1. Coarse brown gravel; ? up to 8 feet thick, resting on a denuded surface of the next.
2. Bluish-grey Boulder Clay, mostly dark, but partly light-coloured, scooping into the next.
3. Brown stony loam, with small bits of shells; up to 12 feet seen; greenish-grey at the bottom at X.

[Well-marked bedding-planes, shell-fragments chiefly *Cyprina*. W. H. D. 1882.]



1. Gravel.
2. Bluish-grey Boulder Clay.
3. Brown stony loam.

Figure 5. Dovetailing of Boulder Clays, Weybread Brickyard.

At a spot near the middle of the pit there was to be seen, in 1882, a dovetailing of the two Boulder Clays, as shown in Fig. 5, and a still more irregular occurrence of the same sort has been noticed by the late Mr. S. V. Wood, Jun.*

Crossing to the left side of the valley, at the back of the westernmost house in Brockdish, a small pit showed in 1880:—

Gravel - - - -	3 feet.
Boulder Clay, thinning eastward	from 3 to 1½ „
Gravel - - -	8 „
Marly Boulder Clay - -	—

The lower clay is seen in the "lump-pit" close by, described on p. 16.

* *Quart. Journ. Geol. Soc.*, vol. xxxvi., Pl. xxi., fig. xv. (1880).

A seam of Boulder Clay appears at Needham, and is traceable to Shotford Bridge, where a large pit shows, over sands, 12 feet of sandy Boulder Clay, belonging to this division, and overlain by the Upper Boulder Clay.

In the tributary valley from the Pulhams, Mr. S. V. Wood, Jun., has described a pit (now run down and planted) a quarter of a mile east of Starston Place, which gave the section shown in Fig. 6, here reproduced through the kindness of the Council of the Geological Society.

*Figure 6. Section in a Pit, East of Starston Place.**

c. Talus,
b. Humus and rain-wash.
7. Light-coloured bedded sands, passing up into bedded gravel.
a. Thin dark brown sandy loam, covering the surface of 6, and at one place filling a pot-hole about 5 feet deep. The + shows where a hole, sunk through the talus, showed this bed passing under 7.
6. Gritty earth, with small flints and minute fragments of chalk. A sandgall at *. This is the Contorted Drift of Mr. Wood.

* *Quart. Journ. Geol. Soc.*, vol. xxxiii., pp. 98, 99.

A trace of the Lower Boulder Clay was again seen in the floor of a pit a quarter of a mile north of Reddenhall church.

W. W. and W. H. P.

Sand and Gravel [Middle Glacial of Wood].

The Glacial sands and gravels of this district are of small importance and of little interest. They are rarely dug for road-metal or for building-material, and but for their furnishing water in the Boulder Clay districts would be without economic value.

Valleys of the Alde and of the Minsmere.

In the bottoms of the branches of the Alde Valley below Brundish and at Baddingham there are short outcrops.

In the Minsmere Valley above Yoxford the outcrop is continuous to near Baddingham Hall.

Below Darsham there are only isolated patches of gravelly sand to represent the deposits of this period, the Boulder clay lying mostly on older beds.

Sand is dug at the back of Little Boys Street, and eastward of the White Horse, Peasenhall.

Valley of the Blyth.

It is possible that there may be some of these beds about Thorington (*see* p. 5) which would probably be continuous under the Boulder Clay, with the small outcrop eastward of Bramfield, where in a small pit, a little N.E. of Castle Yard, light-coloured sand was seen beneath the Boulder Clay.

A similar trace is seen south of Page's Farm, N.W. of the village (*see* p. 6), where, however, the deposit is unmappable.

Another patch extends from Wenhaston Place to Walpole.

The beds probably extend from the Minsmere Valley under the Boulder Clay, to Haveningham, and by Huntingfield to Cookley, Cheddiston, Wisset, and Spexhall.

About three-quarters of a mile west of Ubbeston church, a pit, south of the angle of the road, showed a trace of Boulder Clay over sand and gravel, with sand beneath. (Note from W. W.)

At and below Cheddiston the beds consist largely of gravel, and in an old pit, marked on the map, by the lane a little south-west of Cookley Grange, a pinnacle of consolidated sand and gravel, cemented by carbonate of lime (probably derived from the Boulder Clay), has been left standing in land now again under cultivation. The sand is false-bedded, and the cap is of gravel, the column being 10 feet high, by 8 feet, by 6 feet.

The outcrop between the Duke Inn, N.E. of Holton, and Sotherton seems to be an outlier cut off by the rise of the pebbly gravel.

Nearly a mile W.S.W. of Sotherton Church (in a branch of a side-valley) there was a pit, on the western side of the lane, in gravelly false-bedded sand.

The sand and gravel about Brampton (in another branch of the same side-valley) extend under the Boulder clay to the outcrop in the Waveney valley to the north.

Benacre Valley.

The sand and gravel crops out in the bottom of the Shading-field branch, as well as in the chief branch, north and north-east of Great Redisham.

"At Redisham Hall is seen 3 feet of pebbly sand, only about half the pebbles being flint."*

* From Mr. C. Reid's Notes.

Valley of the Waveney: Up the Right Side.

"In a pit west of the church at St. Lawrence Ilketsall, the sand and gravel contain fragments of shells of *Mya* and *Cardium*."

"At the western corner of Abbey Wood, Flixton (at the northern edge of the district, N. of St. Margaret Southelmham) the following section was seen in a pit:—

	feet.
Loamy soil - - - - -	2
Boulder Clay - - - - -	3
Fine white false-bedded sand, with carbonaceous grains, a few small stones, and shell-fragments - -	10

"Similar sand is seen in a pit three quarters of a mile west of Flixton Hall."*

A pit a quarter of a mile E.S.E. of Sancroft church (in the tributary valley of the Southelmhams), shows fine gravel, underlain by fine yellow sand.

Gravel is dug in several spots north-eastward of Mendham, and fine white current-bedded sand with pebbles, a short half mile southward of the church.

The rise of the Pebbly Gravel about Withersdale cuts out the series under description for a space of a mile along the valley, but it sets in again near the Priory Farm, and though much concealed by the Boulder Clay and River Gravels (which overlap at the northern part of Weybread) it appears to be continuous everywhere to the west.

Gravel is dug at several points in the side-valley below Weybread church, and red sand is seen under Boulder Clay east of Bunting's, Wingfield.

About Syleham, again, in the main valley, there is a good deal of gravel, and about 200 yards south of Monks Hall, is a pit with fine white sand and gravel (containing traces of shells) in the lower part, and coarser gravel above. Erosively scooping into these beds (of which a thickness of 20 feet is exposed) is a trough some 10 feet deep, lined with light-coloured sandy Boulder Clay, and filled with blue Boulder Clay, weathering brown at top, and containing galls of brown sand of fantastic shape.

In the long tributary of the Waveney descending from Worlingworth, the Glacial Gravels are exposed in continuous outcrop from west of Stradbrook downward, nearly to Hoxne.

At and for a quarter of a mile southward of Chickering Bridge very coarse gravel and sand, with many chalk pebbles are to be seen. The rapid percolation of water through such materials is probably one cause of their not being decalcified as much as the Crag sand or the Boulder Clay. Or the water may, before reaching such beds, have been deprived, by contact with other calcareous matter, of all free carbonic acid.

Half a mile east of the house in Oakley Park, Hoxne, is a large pit, showing the following sections in 1880:—

On the Western Side.

		feet.
Post-Glacial Drift.	Coarse gravel, variable.	
Glacial Drift.	Sandy light-grey and buff Boulder Clay, with no large stones, surface dipping S.E. - - -	4–5
	Sand, with a little fine gravel, reddish and horizontally bedded above, white and current-bedded below -	about 9

On the Southern Side.

Post-Glacial Gravel - -		12 feet.
Glacial Drift.	Boulder clay -	8 ,,
	Whitish sand -	—

* From Mr. C. Reid's Notes.

On the Eastern Side.

Sandy gravel, with a southerly dip; 20 feet.

The Post-glacial gravel, dipping towards the valley on the south, abuts against a boss of the Boulder Clay, and the junction shows a pseudo-passage, some of the clay being worked up into the gravel beds.

Valley of the Waveney: Down the Left Side.

"South of the high road, a quarter of a mile west of the windmill on Billingford Common, is a large pit, 20 feet deep, in coarse sub-angular gravel, with signs of bedding at the bottom part, and with some pebbles of chalk of quartz and of quartzite."*

About half a mile west by south of Needham church a pit is worked in fine chalky and coarse sandy gravel.

There are large gravel-pits half a mile N.E. of the church, extending down to the seam of Lower Boulder Clay already mentioned (p. 20). About a quarter of a mile east of this is the subject of the following note:—"A pit one mile from Harleston towards Diss, where 4 feet of blue clay, abounding with chalk pebbles, are overlaid by 2 feet and underlaid by 10 feet of gravel and flints."†

The Boulder Clay here mentioned is not the seam of Lower Boulder Clay but the edge of the Upper, and the gravel above it is of early Post-glacial age.

There is a good deal of reddish sand and gravel about Wortwell (Reddenhall) and up the tributary valley eastward.

The junction of the Boulder Clay, with the beds under description, is a gradual passage near Starston, and near the 105th mile-post on the railway a pit shows stiff grey and whitish clay passing down irregularly, by alternations with brownish-yellow sand and chalky gravel, into fine buff loamy sand.

Three quarters of a mile westward along the railway the junction shows the usual sharp change from sand to clay, and the same is the case on the northern side of the valley at Pulham St. Mary Magdalene, and eastward of Starston Place.

Half a mile east of Starston church, a pit by the roadside shows alternations of whitish and ferruginous sand and gravel.

Large gravel-pits are worked half a mile N.E. of Harleston Station, and sandy gravel is raised in the hollow N.W. of Reddenhall.

Mr. C. Reid has noted the following section as occurring, "a quarter of a mile north of Reddenhall Church":—

Gravel, 10 or 15 feet.
Bedded brickearth, or loam, about 5 feet.
Sandy chalk-gravel.

About half a mile N.E. of Reddenhall, coarse angular gravel is raised from some large pits on the southern side of a ridge, the northern face of which consists of Boulder Clay, descending to the level of the valley or lower. A quarter of a mile east of this, and three quarters west of Homersfield church, an old roadside pit shows gravelly sand under Boulder Clay.

Upper Boulder Clay.

General Remarks.

The Upper Boulder Clay presents in this district its usual characters, being chiefly a tough bluish-grey clay, crowded with stones, among which chalk and flint predominate; though older rocks form an important proportion.

* From Mr. F. J. Bennett's Notes.

† Dr. J. Mitchell, *Proc. Geol. Soc.*, vol. iii., no. 59, pp. 3, 4 (1838).

The weathering of this clay, by the prolonged access of water in the more level parts and by the penetration of roots everywhere, produces a stiff yellow clay containing much coarse sand, and, of course, all the stones except those of chalk.

The necessary collection of stones from the fields, supplies the clay-districts with road-metal, whilst the clay is used for bricks and "lumps" (air-dried rectangular blocks of clay well worked-up with straw, and used for rough building, with moist clay as setting).

It is, as a rule, only where the junction with lower beds is laid open, along the valleys, that sections are of interest.

Valleys of the Alde and of the Minsmere.

The only noteworthy section in the former valley has already been described, p. 11.

The base of the clay is seen on the road a mile east-south-east of Yoxford, resting on Crag sand. Its course up the valley from Yoxford to Peasenhall offers no points of interest on either side.

Near the river, southward of Darsham, is a small outlying patch of the clay.

In a pit, at the back of the farm, less than half a mile southward of Darsham church there is grey Boulder Clay, up to 8 feet or more thick, over buff bedded sandy Boulder Clay. (Note from W. W.)

Valley of the Blyth.

In the Bramfield tributary valley the few sections worth notice have already been described in connection with the Crag and the Pebbly Gravel, on which the Boulder Clay rests indifferently in the absence of Glacial sands (*see* pp. 5, 6, 14).

Up the valley to Laxfield and Cratfield, the base of the clay lies evenly over whatever happens to be underneath it, Crag, Pebbly Beds, or Glacial Sands. South of Cookley Wood, however, the clay occupies a trough in the gravels below it, and eastward of Cookley House is an outlier, at the bottom of the slope of Crag sand.

A similar patch, on the base of the Pebbly Gravel, lies half a mile south of Halesworth, whilst the base of the main mass runs round almost horizontally into the tributary valleys on the north, except that in Cheddiston Park it is rather lower down.

The small outliers at Thorington, Wenhaston, and Mells Chapel exhibit no special features.

The way in which masses of the Chillesford Clay and of the Pebbly gravels have been torn up and embedded in the Boulder Clay of Halesworth brickkiln has been referred to at p. 9, and this section is almost the only one in the district that has any interesting points as regards Boulder Clay.

The clay has been worked for bricks on the west of Cheddiston Park, and half a mile north-east of Halesworth station. Its characters in the cutting at the station have been described on p. 15. W. H. D.

A gamekeeper told me that the many pits in the wood marked on the old Ordnance Map as "The Clumps" (but which, he said, ought to be "The Clamps") about a mile and a quarter south of Sotherton, were dug for brick-earth, and that the bricks for Bulchamp Workhouse (and for Henham Hall?) were made here. As there is now no evidence of the occurrence of loam, whilst Boulder Clay occurs roundabout, this tract has been coloured as the latter. W. W.

Valley of the Waveney.

The somewhat uneven base of the Boulder Clay in the neighbourhood of the Southelmhams (there are only seven parishes of that name, distinguished by the names of the saints to whom their churches are dedicated) is shown by the presence of several small inliers of sand and gravel, protruding in the bottoms of tributary valleys, from under the pall of clay.

The surface on which the Boulder Clay rests between Mendham and Weybread is also somewhat irregular. Its slight slope toward the valley produces at Mendham a strip of clay lying below the outcrop of the gravels on the east. At Weybread again the clay passes under the broad spread of River Gravel of Shotford Heath, and forms the floor of the large rectangular pit, about six and a half acres in area, in front of Heath House.

The wells about Hoxne show a sheet of gravel several feet in thickness in the middle of the Boulder Clay; the occurrence of this seam, which is not seen anywhere at the surface, appears to be rather irregular. At the rectory, west of the church, it must be about 11 feet thick, judging from the record of the old dug well, and of the more recent boring. The variations in thickness, character, and level of this gravelly bed may be seen from the well-sections in the Appendix (p. 37).

In the main valley of the Waveney the clay descends nearly (or in parts, quite) to the river below Hoxne and Billingford, whilst wells at Dickleburgh, in the plateau to the north, show its base close to the surface (*see* p. 34). A consideration of the form of the surface on which the clay rests will show that the upper part of the valley is in a line of depression of this surface, and that Post-glacial erosion has but slightly modified the gradients of the district.

Owing probably to the nearly dead level of the clay plateau on which Harleston stands, the Boulder Clay has been subjected in an unusual degree to the influences of percolating waters, and their resulting changes.

The clay is worked for bricks between Sancroft and St. Margaret, Southemham, and at Metfield, and a peculiar form of it is seen about a quarter of a mile north of Metfield church. Under clay of the normal type is fine brown and grey streaky loam with small grains of chalk. As the Glacial sands are wanting hereabouts, this loam is possibly the representative of the Lower Boulder Clay.

A quarter of a mile south-east of Syleham church the base is seen to consist of black clay, overlying gravel and sand. South of Monks Hall the clay lies in a hollow eroded in the underlying beds.

Far up the Worlingworth side-valley, Boulder Clay is worked for brick-making, about three quarters of a mile eastward of Athelington. At Worlingworth, some 700 yards north-west of the church, it has the unusual form of sand and clay, with beds of angular stones; a bed of grey sand being seen at the bottom of the section.

The brickyard a mile north-west of Needham shows 8 feet of stiff brown and blackish loam over ordinary Boulder Clay, and the well here reaches sandy gravel.

There are two outliers, one very minute, above Wortwell, showing the former extension of the clay over the ridge eastward of Reddenhall.

Going up the Starston Valley, the base of the series, at the brickyard half a mile west of Reddenhall church, is a sandy brickearth under dark blue Boulder Clay, which weathers nearly white.

At Harleston a saw-pit, on the premises of Messrs. Knights and Stacey, showed a confused mixture of grey loam, coarse sand, and gravel.

There are no other exposures worthy of note in the Starston Valley, which have not been already mentioned in connection with lower beds; the brickyard at Mill Mount, Pulham South Green, and that N.E. of Starston, showing only Boulder Clay.

W. H. D.

CHAPTER 4.

Post-Glacial Deposits.

The older Post-glacial deposits (using the term in the restricted sense of beds formed after the cessation of glacial conditions, but before the minor existing geographical features took origin) consist in this district of certain gravels and loams, in the production of which the present rivers had little or no part, even if they existed. They are known only within the area drained by the Waveney, and are of very limited extent.

Weybread, &c.

The gravel overlying the Boulder Clay at Weybread Brickyard has already been described (p. 19). A better section occurs a little further up the hill, on the top of which the Boulder Clay re-appears, so that we have here a shelf in the clay, piled with gravel, a thin spread of which lies yet higher up to the west.

The patch on the high road south-west of Harleston, described on p. 23, is very similar in its structure and position, and the two may have been continuous at a time when the brooks from the Southelmhams, Metfield, Fressingfield, Worlingworth, and Redlingfield fed, not the Waveney, but the Little Ouse, as indicated by the westward trend of their channels, and by the slight difference of level between Mendham and Lopham Ford (in Sheet 50, N.W.)

Hoxne.

At Hoxne the junction of three of these Post-glacial streams produced a lake, in which gravels and loams were deposited, whilst Palæolithic man lived on its shores and flung his rude stone weapons at passing game, in such quantity that many bushels are said to have been found in the gravels of the brickyard, a statement hardly confirmed by their rare occurrence in recent years. The sequence of beds in this deposit has been much studied, in consequence of the discovery of these flint implements.

Mr. John Frere first described the brickyard-section, which in his day was as follows*:—

	Feet.
Vegetable earth -	- 1½
Clay - -	- 7½
Sand, with shells and bone	- 1
Gravel, with flint implements	- 2

The literature of palæolithic implements contains many references to Hoxne,† but we shall note only such as refer to strati-

* *Archæologia*, vol. xiii., p. 206 (1800).

† We may instance Dr. J. Evans' Flint Implements in the Drift, *Archæologia* 1862; The Ancient Stone Implements Weapons and Ornaments of Great Britain, 1872, by the same author; and Sir J. Lubbock's Prehistoric Times, 1878.

graphical details. Prof. PRESTWICH examined the ground very thoroughly in 1859, 60, and recorded many details. A full abstract of his observations will now be given.*

The south-western corner of the brickfield showed the following sections in 1859 :—

	Feet.
a. Surface soil, traces of sand and gravel - - -	1–2
b. Brown and greyish clay, not calcareous, with an irregular central carbonaceous or peaty seam. Two flint-implements had been found, one just below this seam, the other near the bottom of the bed. Bones of *Bos* and *Elephas* -	10–12
c. Yellow subangular and sometimes clayey flint-gravel, with some small chalk-pebbles and a few pebbles of sandstone of quartz and of other old rocks. Bones of mammalia. Like *b*., this thins out westward - - - -	0–1
d. Bluish and grey calcareous clay, in places very peaty; the lower part with sand-partings. Contains remains of Oak, Yew, Fir, Bilberry, land and freshwater shells, Cyprides,‡ and mammalian bones (deer, horse, and elephant). There were sandy partings with shells of the following mollusca in a perfect but very friable condition :— †Arion ater, *Linn.* (some calcareous grains); Bythinia tentaculata, *Linn.*; Helix hispida, *Linn.*; Limnæa palustris, *Müll.*; L. truncatula, *Müll.*; Planorbis albus, *Müll.*; P. spirorbis, *Müll.*; Succinea putris, *Linn.*; Valvata piscinalis, *Müll.*; Zonites (Helix) nitidulus, *Drap.*; Pisidium amnicum, *Müll.*; Sphærium (Cyclas) corneum, *Linn.*; and Unio (fragmentary) - - - -	3–4
e. Gravel like *c*, but finer, more worn, and with more chalk pebbles - - - - -	1–2½
f. Calcareous grey clay, more or less peaty, with freshwater shells. Bottom not reached by boring - -	to 17

A trench on the eastern side of the field gave this section :—

		Ft.	in.
Post-Glacial	Ochreous sand and gravel, passing down into white sand - - - - -	4	9
	Seams of fine white and ochreous gravel -	1	3
	Light-grey sandy clay - - -	0	8
	Coarse yellow gravel, with a flint implement -	1	0
	Grey and brown clay, with abundance of *Bithinia* - - - - -	2	4
Boulder Clay	- - - - - - -	1	0

Another trench, also on the eastern side of the field, showed :—

Yellow sand, with a few flints, passing into -	3½ feet.
Ochreous gravel - - - - -	1 „
Grey clay - - - - -	1 „
Gravel full of water.	

A trench on the southern side of the field exposed :—

Ochreous drift sand and gravel - -	3 to 4 feet.
Brickearth - - - -	4 „
Fine gravel, mostly small chalk-pebbles -	2½ „
Grey clay.	

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* *Phil. Trans.*, vol. cl., pp. 304–308, pl. xi.

† Added in a later paper, *Phil. Trans.*, vol. cliv., p. 283 [1864].

The several trenches shown, on the plate of Prof. Prestwich's paper, as crossing the east and west section-line, are as follow :—

1. 250 yards west of the park-fence—
   Sand, 2 ft., on Boulder Clay.
2. 50 yards west of the park-fence—
   Sandy loam, 13 ft. Gravel, 1 ft.
3. In brickyard pit, 12 yards east of road-fence—
   Boring through *d*, *e*, and 17 ft. of *f*.
4. 100 yards east of road-fence—
   c and *d* 5 ft. on *f*.
5. Trench and bore 140 yards east of road-fence—
   c 5 ft., *d*, *f* 8 ft.
6. 10 yards east of 5, is the 11 ft. trench described above.
7. 50 yards west of Goldbrook, reaches Boulder Clay under a foot or two of sand and gravel.

8 and 9, below and above the clay-pit east of the brook, show, like it, only Boulder Clay under the sandy wash.

A trench in the meadow on the north of the brickfield, close to the road, and 18 chains from Fairstead Farm, showed Boulder Clay at the surface. A space of about 10 chains wide is shown on the section between the older Post-glacial deposits of the brickfield and the slightly newer gravels that extend to Goldbrook. No indication of this intervening belt of Boulder Clay is visible now, and it is probably narrower, and possibly not continuous on the surface with the main sheet of Boulder Clay to the east.

In 1876 Mr. T. Belt undertook to establish the *interglacial* age of the Hoxne palæolithic gravels and loams.* He lays much stress on the occurrence of the sandy and clayey rainwash, alike on the Boulder Clay and other beds, which he calls *trail*, and regards as a true formation and of Glacial age. He denies the similarity, not to say identity, of the Boulder Clay of the clay-pit, with that constituting the surrounding country, and asserts that the clay-pit is in Lower Boulder Clay, that the gravels and loams of the brickfield are Middle Glacial, and that the clay *b* of Prof. Prestwich's account is the Upper Boulder Clay! The mere presence of land and freshwater shells, bones, and plants would suffice to disprove this correlation with any part of the Glacial series, which is wholly of marine origin; whilst the absence of any similarity of the beds *b*, *d*, or *f*, of Prof. Prestwich's section, with the Boulder Clay, and the identity in character of the underlying chalky clay with that widespread formation are merely additional arguments in favour of Prof. Prestwich's reading of the evidence. It may be added that Mr. Belt refers to *d* as red brick-earth, and *f* as white brick-earth, local terms denoting the colour of the resulting bricks, &c., *not* that of the raw clays. The carbonaceous matter in the lower bed reduces any iron that may be present to colourless protoxide, carbonate, or silicate, whilst in *d* no such reduction takes place, but peroxidation occurs.

W. H. D.

In 1880 Mr. S. V. Wood, Jun., came to the conclusion "that the Hoxne palæolithic brick earth . . . . . is of the age of the

* *Quart. Journ. Sci.*, n. ser., vol. vi., pp. 289–304.

Chalky [Boulder] Clay itself, though of the latest part of it," regarding the deposit as having been formed in an ice-dammed lagoon.*

MR. H. B. WOODWARD, noting MR. BELT'S record of "traces of Chalky Boulder Clay on the Hoxne Beds," adds, "MR. REID, and myself subsequently observed two tiny traces of this Boulder Clay on the brickearth in the pit in the park."† In the present year my colleague describes these traces as "small pockets"; but cautiously remarks that "in the present state of the evidence it is not safe to say that any Palæolithic Implements have been obtained in East Anglia from beds older than the main mass of the Chalky Boulder Clay, or from that Clay itself."‡

MR. DALTON suggests that any such small patches of Boulder Clay may have been brought into their present position by man, a view which one may regard as within the bounds of possibility; although MR. REID writes that "they seemed to have been there for a long while, for they were grassed-over, and, if I remember rightly, an oak-tree was growing on one." Neither MR. DALTON nor myself had the good fortune to see any Boulder Clay over the loam, and we both think the latter, with its freshwater shells, more like a Post-Glacial than a Glacial deposit.

Through the kindness of Dr. J. EVANS we are enabled to reproduce two excellent woodcuts of flint implements found at Hoxne, in Figs. 7, 8.§ The tool shown by the former of these was found by Dr. EVANS himself, in the disturbed upper soil of the worked-out part of the pit, into which it had probably been thrown by the workmen: the other, also in his collection, is remarkable for the extent of twist, as seen in the edge-view. In each case a side view, an edge view, and a section through the broadest part is given.

The specimens found by Mr. FRERE are in the collection of the Society of Antiquaries. Others may be seen in the British Museum, in the Blackmore Museum (Salisbury), in the Woodwardian Museum (Cambridge), and in the Ipswich Museum, and some were kept by the late SIR E. KERRISON (the landowner) and are still at Oakley Park.

W. W.

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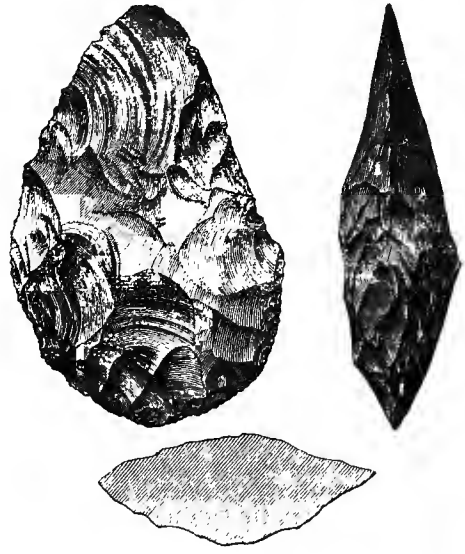
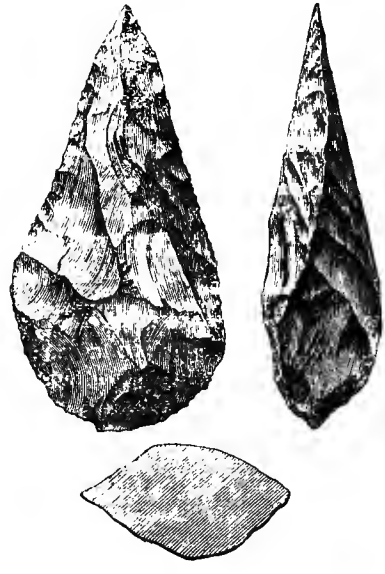
* *Quart. Journ. Geol. Soc.*, vol. xxxvi., p. 497 (and vol. xxxviii, p. 669).
† *Proc. Norwich Geol. Soc.*, pt. ii, p. 62 (1879).
‡ The Geology of England and Wales, Ed. 2, p. 515. 8° *Lond.*
§ Figs. 449, 450 of his "Ancient Stone Implements . . . of Great Britain."

Figures 7, 8. Flint Implements from Hoxne. Dr. J. Evans.





The brickyard at Athelington, now in work, can hardly be on the same site as in 1860, when, as Prof. PRESTWICH states, a freshwater deposit, like that of Hoxne, was seen under 8 feet of ochreous gravel and sand.* No such gravel could be seen when the Geological Survey was in progress, nor any freshwater loams.

River Gravels.

The gravels lying at various levels on the slope below Billingford and about Thorpe Abbots offer no special features. They are, of course, older, looked at as a whole, than the level terraces which fringe the borders of the alluvial flats of the Waveney at intervals, now on one bank, now on the other, and sometimes simultaneously on both. But these older gravels are doubtless of various ages, representing, in their sloping beds and surfaces, the gradual erosion of the valley-floor, too uniform to admit the production of shelves or terraces, except on a scale too small to be now perceptible: a series of minute terraced steps rapidly changing by cultivation and rainwashing to a regular slope.

Where the Boulder Clay is the material on which such slight shelves have been formed there might be detected belts of varying degrees of humidity in the overlying gravel, but the latter would still form a continuous draping, though not of precisely the same age throughout.

The same remarks may be applied, in a few cases, to the more recent gravels. The broad terrace of Shotford Heath, for instance, is a good deal higher than the narrow terrace at Weybread Cottage, yet the two gravels are hardly separable east of Heath House.

W. H. D.

Mr. C. REID has noted the nature of the beds in the terraces at Homersfield and Wortwell (Reddenhall) as follows:—

"At Homersfield, north of the church, coarse gravel, principally of flints, roughly bedded, was seen to the depth of about 10 feet."

"At Wortwell, north of the Railway Station, coarse flint gravel, 7 feet thick, was seen resting on white sandy false-bedded gravel, dug to the thickness of about 10 feet."

A pit, which Mr. Reid notes as "three-quarters of a mile S.W. of Homersfield Station," and which therefore must be close to the last, "gave a good section in 1876 though the junction was not well shown, of unworn flint gravel, 10 feet thick, over pebbly sand (Bure Valley Beds) to over 5 feet."

A third pit, "3 furlongs west of Homersfield church, had coarse ferruginous gravel in the upper part and white sandy gravel in the lower."

Another near by, "3 furlongs S.W. of Homersfield Station, seems again to be in unworn flint-gravel over pebbly sand (Bure Valley Beds)."

In the valley of the Blyth but two small tracts of river-gravel have been noticed, fringing the marsh on the right side at Wenhaston, and on the left side just below Holton, and forming nearly flat ground rising gently from the marsh-level.

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* *Phil. Trans.*, vol. cl., p. 308.

Alluvium.

Of the deposits forming the marshes of the present streams little can be said, as sections are not made in them, except for ditches.

The ditch on the Southwold Railway, just above Mills Bridge, Holton, at one spot illustrates the washing down of gravel over the alluvium, which process causes a slight rise above the marsh-level.

The railway-ditches just below Mills Bridge show the peaty margin of the gravel bordering the alluvium, and then the peaty alluvium itself, which was also seen in the ditches S.W. of Blythford church.

The topography of the Map S. of Bulchamp Union Farm, and at the junction with 49 N., is bad. One could not survey the alluvium properly, and had to go by the hill-shading (which is the best part of the Map) in drawing the line between the Crag and the gravel.

W. W.

APPENDIX. WELL-SECTIONS.

The measurements are in feet.

NORFOLK.

LIMMER=Sunk and communicated by Mr. W. LIMMER of Dickleburgh.—(F. J. BENNETT).

BILLINGFORD. Rectory. (LIMMER.—F. J. B.)

Water rose 4 feet.

		Thickness.	Depth.
[Glacial Drift]	Gravel and sand	45	45
	Loam	10	55
Chalk		15	70

DICKLEBURGH. Rectory. (LIMMER.—F. J. B.)

Sand (water rose 4 feet), 20 feet.

DICKLEBURGH. Mr. Smith's. N. of house, at the mill.

Communicated by Mr. SMITH.—(F. J. B.)

Shaft, 35 feet; the rest bored.

A strong spring of water (ferruginous), rose 55 feet.

Sand, 70 feet.

There is some doubt as to these two sections, the surface of the district being Boulder Clay.—(W. W.)

DICKLEBURGH. Mr. Smith's (miller). E. of house.

Communicated by Mr. SMITH.—(F. J. B.)

[Glacial Drift]	[Boulder] Clay	20 feet.
	Sand	6 „

DICKLEBURGH. 200 yards E. of Mr. Smith's.

Communicated by Mr. SMITH.—(F. J. B.)

[Boulder] Clay, to sand and water, 135 feet.

DICKLEBURGH. Mr. Simpson's, in the village. (LIMMER.—F. J. B.)

Sunk 50 feet, and then bored 50 feet in [Boulder] Clay.

HARLESTON. (LIMMER.—F. J. B.)

1. E. end of town; 2. Market Place; 3. New Malting by Railway Station; 4. By the Swan Inn.

		1.	2.
Sand	-	40	30

		3.	4.
[Glacial Drift] - [Boulder] Clay	-	45	30
Sand	-	Touched	10

5. White House. Water rose 4 feet.

[Glacial Drift]	[Boulder] Clay - -	5
	Gravel, sand, and loam -	93

PULHAM ST. MARY. The Hall. (LIMMER.—F. J. B.)

Water rose 4 feet.

[Glacial Drift]	[Boulder] Clay -	30
	Loam and sand -	20

PULHAM ST. MARY. By Station. (LIMMER.—F. J. B.)

Boulder Clay, to sand and water (water rose 55 feet), 60 feet.

REDDENHALL. Well in sand-pit at Wortwell.

Communicated by Mr. D. PALMER.—(C. REID.)

[Glacial Drift]	Sand -	6
	Brickearth -	17

To white clay [? chalk].

RUSHALL. (LIMMER.—F. J. B.)

1. ? Locality. 2. Half Moon Inn. 3, 4. Longmoor Green, south-westward of the village. (Water rose 9 feet).

		1.	2.	3.	4.
[Glacial Drift]	[Boulder] Clay	30	33	60	50
	Sand - -	Touched (water).	15	Touched	Touched

STARSTON. The Green. (LIMMER.—F. J. B.)

[Glacial Drift]	[Boulder] Clay -	20
	Gravel and loam -	76

STARSTON. A quarter of a mile E. of the church. (LIMMER.—F. J. B.)

		Thickness.	Depth.
[Glacial Drift]	Gravel	12	12
	Sand and loam	10	22
	Sand	24	46

SUFFOLK.

DAY = Sunk and communicated by Mr. G. DAY, of Eye.—(F. J. BENNETT.)

BADDINGHAM.

Rev. W. B. CLARKE. *Trans. Geol. Soc.*, ser. 2, vol. v., pt. 2, p. 377. (1840).

Diluvial [Boulder] Clay, 80 feet.

BRAMFIELD. Nearly a mile west of Hall. 1880.

About 120 feet above Ordnance Datum.

Sunk and communicated by Mr. T. TILLEY, [and from samples].

		Thickness.	Depth.
[Boulder Clay]	Old Well	70	70
[? Crag, over 53 feet.]	Brown sand [fine buff sand], dry	8	78
	Red sandy loam [brown sand], dry	14	92
	Live sand with water [light-grey, nearly buff, micaceous]	31⅓	123⅓
[Basement-bed of London Clay.]	Hard calcareous grit, with casts of shells, as a crust over light-grey shelly sand	6⅔	130
[Reading Beds, 36 feet.]	Blue [dark grey] clay	6	136
	Black [peaty] clay	5	141
	Blue clay [dark grey, partly veined buff]	23	164
	Green sand and flints [dark green sandy clay]	2	166
Chalk [soft]		84	250

HOXNE. (DAY.—F. J. B.)

1. Abbey (water rose 6 feet). 2. Infant school (by church). 3. (water rose 6 feet) and 4. Pig Street. 5. By Church (water rose 3 feet). 6. Lower part of village.

		1.	2.	3.	4.	5.	6.
[Glacial Drift]	[Boulder] clay	45	50	50	18	35	—
	Sand, or	10	15	10	—	—	20
	Gravel	—	—	—	6	15 (coarse)	—

HOXNE. Burnt House. (DAY.—F. J. B.)

Water rose 6 feet.

		Thickness.	Depth.
[Glacial Drift]	[Boulder] clay	26	26
	Gravel	4	30
	[Boulder] clay	20	50
	Sand	4	54

HOXNE. Heckfield Green. (DAY.—F. J. B.)

[Glacial Drift]	[Boulder] Clay	40	70
	Loam and sand, in layers	10	
	Sand	20	

HOXNE. (DAY.—F. J. B.)

1. Lion Inn, Cross Street, near the Abbey (water rose 20 feet). 2. Timber-yard and saw-mill (water rose 14 feet).

		1.	2.
[Glacial Drift]	[Boulder] clay	35	25
	Sand	10	5
	[Boulder] clay	15	20
	To gravel	—	—

HOXNE. Oakley Park, W. of the village. 1877 ?

Made and communicated by Messrs. BENNETT, of Ipswich.

An account of the old well, from Mr. G. DAY, gives the section clay 10 feet, gravel 5, and clay 7, or 10 feet less than the depth marked below. This may, however, be at a different site.

		Thickness.	Depth.
Old well		—	32
[Glacial Drift]	Light [-coloured clay]	2	34
	Blue clay and sand	3	37
	Sharp shingle and sand, like beach	25	62
[? Crag and ? Eocene.]	Light-green crag and sand	27	89
	Light-green clay	1	90
	Light-green crag and sand	39	129
	Light-green clay	7	136
	Flints	1½	137½
Chalk		31½	169

Hoxne. Rectory. 1877.

Made and communicated by Messrs. Bennett, of Ipswich.

An account of the old well, got by Mr. F. J. Bennett from Mr. G. Barham, of Winfarthing, shows 39 feet of clay over sand, to the depth of 45 feet, or 5 less than marked below.

		Thickness.	Depth.
Old well		—	50
[Boulder] clay and large flints. [Specimen of brownish sandy clay, with bits of stone, at 70 feet]		24	74
[? Drift, ? Crag, and ? Eocene.]	Loose running sand and crag (red)	17	91
	Light-blue clay	1	92
	Loose running sand and crag [many specimens of *Purpura lapillus*]	60	152
	Light-coloured clay	$9\frac{1}{2}$	$161\frac{1}{2}$
	Flints	$1\frac{1}{2}$	163
Chalk		40	203

Saint Margaret Southelmham.

Communicated by Mr. D. Palmer.—(C. Reid.)

1. Mr. Freestone's. Two wells, not 200 yards apart, 120 feet of [Boulder] Clay to sand. In one the water rose to within 60 feet of the surface.
2. The Rectory. About 80 feet of [Boulder] Clay.
3. Southelmham Hall. [Boulder] Clay 10 feet, sand 60 feet.

Sotherton. Cottages about $\frac{3}{4}$ mile S.W. of church.

Sunk and communicated by Mr. J. Dade, of Wrentham.—(W. W.)

About 4 feet of water.

[Glacial Drift.]	[Boulder] Clay	about 30	71
	Sand	„ 40	

Westleton. From information on the spot.—W. W.

1. Windmill at N. end of village. 80 feet of white sand.

2. House nearly half a mile E. of church, on northern side of road. Said to be the same; but there must be some loam or Boulder Clay, and a little gravel, at the top.

3. Windmill, marked on the map, nearly half a mile S.E. of the church, 45 feet of gravel, to sand and water.

The following sections in districts to the south (Sheets 50, S.E., and 48, N.W.) having come to hand since the Memoirs thereon were published, are printed here.

Benhall. Mr. Holland's, Benhall Lodge. 1886, 87.

Made and communicated by Mr. F. Bennett (late Messrs. Bennett), of Ipswich.

Old well 46 feet, the bottom 5 feet filled with concrete; the rest bored; pipes carried 2 feet 2 inches above the concrete.

Water stood 2 feet 4 inches in the bore-pipe, above the level of the water in the old shaft.

		Thickness.	Depth.
Old well [through Boulder Clay, and sand?]		—	46
[Drift or Crag]	Running sand	6	52
[Red Crag]	Shelly crag	22	74
[? London Clay, 35 feet.]	London clay	26	100
	Loamy sand	9	109
[Reading Beds, 41 feet.]	Dark stiff clay	5	114
	Mottled clay	4	118
	Mottled loam	9	127
	Light [-coloured] sand, or sandy loam	3	130
	London or blue clay	17	147
	Dark brown clay	2	149
	Flints (and chalk)	1	150
Upper Chalk, with flints at 210, 214½, 223, 255, 271, 273½, and 284		151	301

Brantham. British Xylonite Company. On the Marsh by the side of the Stour, and north of the railway, E.S.E. of Catawade Bridge. 1887.

Made and communicated by Messrs. Legrand and Sutcliff. With some particulars from Mr. H. Miller, of Ipswich.

About 5 feet above Ordnance Datum. Bored throughout.

Water found at 10 feet in the Chalk, increasing in quantity as the boring went on; rose to 2½ feet above the ground; and has been tested up to 20,000 gallons an hour.

		Thickness.	Depth.
[River] Gravel		23	23
Blue [? London] Clay		2	25
[Reading Beds]	Black and red sandy clay	2	27
	Mixed clay and sand	13	40
	Silty clay and sand	20	60
	Sand and flint	2	62
Soft chalk and flints		100	162

According to a note in *The Engineer*, vol. lxiii., p. 362 (1887), the first 32 feet took several days in boring, but the rest was bored in 5 days, in one of which no less than 50 feet of chalk and flints were penetrated.

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Scale, one inch to a mile.

Anglesey, 78 (SW).
Bristol and Somerset, 19, 35.
Coalbrook Dale, 61 (NE & SE).
Clee Hill, 83 (NE, NW).
Flintshire and Denbighshire, 74 (NE & SE), 70 (NE, SE).
Derby and Yorkshire, 71 (NW, NE & SE), 82 (NW & SW), 81 (NE), 87 (NE, SE), 88 (SE).
Forest of Dean, 43 (SE & SW).
Forest of Wyre, 61 (SE), 55 (NE).
Lancashire, 80 (NW), 81 (NW), 89, 88 (SW, NW).
Leicestershire, 71 (SW), 63 (NW).
Northumberland & Durham, 103, 105, 166 (SE), 109 (SW, SE).
N. Staffordshire, 72 (NW), 72 (SW), 73 (NE), 60 (SE), 81 (SW).
S. Staffordshire, 54 (NW), 62 (SW).
Shrewsbury, 60 (NE), 61 (NW & SW).
South Wales, 36, 37, 38, 40, 41, 42 (SE, SW).
Warwickshire, 62 (NE SE), 63 (NW SW), 54 (NE), 53 (NW).
Yorkshire, 88 (NE, SE), 87 (SW), 92 (SE), 93 (SW).

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Scale, six inches to a mile.

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Lancashire.

Sheet.	Sheet.	Sheet.
15. Ireleth.	78. Todmorden.	97. Oldham.
16. Ulverstone.	77. Chorley.	100. Knowsley.
17. Cartmel.	78. Bolton-le-Moors.	101. Billinge.
22. Aldingham.	79. Entwistle.	102. Leigh, Lowton.
47. Clitheroe.	80. Tottington.	103. Ashley, Eccles.
48. Colne.	81. Wardle.	104. Manchester, Salford.
49. Laneshaw Br.	84. Ormskirk.	105. Ashton-under-Lyne.
55. Whalley.	85. Standish.	
56. Haggate.	86. Adlington.	
57. Winewall.	87. Bolton-le-Moors.	106. Liverpool.
61. Preston.	88. Bury, Heywood.	107. Prescott,
62. Balderstone.	89. Rochdale, &c.	108. St. Helen's.
83. Accrington.	92. Bickerstaffe.	109. Winwick.
64. Burnley.	93. Wigan.	111. Cheedale.
65. Stiperden Moor.	94. West Houghton.	113. Stockport.
69. Layland.	95. Radcliffe.	118. Part of Liverpool.
70. Blackburn.	96. Middleton, Prestwich.	
71. Haslingden.		
72. Cliviger, Bacup.		

Durham.

1. Ryton.	6. Winlaton.	11. Ebchester.
2. Gateshead.	7. Washington.	12. Tantoby.
3. Jarrow.	8. Sunderland.	13. Chester-le-St.
4. S. Shields.	9. ———	16. Hunstanworth.
5. Greenside.	10. Edmondbyers.	17. Waskerley.

Durham—*continued.*

Sheet.	Sheet.	Sheet.
18. Muggleswick.	25. Wolsingham.	38. Maize Beck.
19. Lanchester.	26. Brancepeth.	41. Cockfield.
20. Hetton-le-Hole.	30. Benny Seat.	42. Bp. Auckland.
22. Wear Head.	32. White Kirkley.	46. Hawkshill Ho.
23. Eastgate.	33. Hamsterley.	52. Barnard Castle.
24. Stanhope.	34. Whitworth.	58. Winston.

Northumberland.

44. Rothbury.	86. Cramlington.	98. Walker.
45. Longframlington.	81. Earsdon.	101. Whitfield.
	82. NE. of Gilsland.	102. Allendale Town.
48. Broomhill.	83. Coadley Gate.	
47. Coquet Island.	87. Heddon.	103. Slaley.
54. Longhorsley.	88. Long Benton.	105. Newlands.
55. Ulgham.	89. Tynemouth.	106. Blackpool Br.
56. Druridge Bay.	91. Greenhead.	107. Allendale.
63. Netherwitton.	92. Haltwhistle.	108. Blanchland.
64. Morpeth.	93. Haydon Bridge.	109. Shotleyfield.
65. Newbiggin.	94. Hexham.	110. Wellhope.
72. Bedlington.	95. Corbridge.	111. Allenheads.
73. Blyth.	96. Horsley.	112. ———
	97. Newcastle.	

Cumberland.

55. Searness.	65. Dockray.	74. Westwater.
56. Skiddaw.	69. Buttermere	75. Stonethwaite Fell.
63. Thackthwaite.	70. Grange.	
64. Keswick.	71. Helvellyn.	

Westmorland.

2. Tees Head.	12. Pattordale.	25. Grasmere.
6. Dufton Fell.	18. Near Grasmere.	38. Kendal.

Yorkshire.

	116. Conistone Moor.	280. Honley.
7. Redcar.		261. Kirkburton.
9. ———	133. Kirkby Malham.	262. Darton.
12. Bowes.		263. Hemsworth.
18. Wycliffe.	184. Dale End.	264. Campsall.
20. Lythe.	185. Kildwick.	272. Holmfirth.
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	201. Bingley.	274. Barnsley.
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33. ———	204. Aberford.	281. Langsell.
38. Marske.	215. Pecke Well.	282. Wortley.
39. Richmond.	216. Bradford.	283. Wath upon Dearne.
46. ———	217. Calverley.	
47. Robin Hood's Bay.	218. Leeds.	284. Conisborough.
	219. Kippax.	287. Low Bradford.
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